Intel® Xeon® Processor E7 Family Performance and Model Numbers

Intel® Xeon® Processor E7-8800/4800/2800 Product Families Characteristics and Impact to Performance

EXECUTIVE SUMMARY

Just like many automobile manufacturers and other companies that have multiple product lines within their product family, server processors have model numbers to help distinguish the differences in features and delineate value. As your business grows, so does demand for your products and / or services with additional customers, users, and transactions that strain your current IT infrastructure and back-end databases. The Intel® Xeon® brand helps customers select the appropriate product line and family stack as their demand justifies it[1].

This paper focuses specifically on the Intel Xeon processor E7 family which is designed to be expandable and scalable for larger deployments of business- or mission-critical workloads such as on-line transaction processing, physical-to-virtual machine consolidation projects, business intelligence, customer relationship management (CRM), and enterprise resource planning (ERP) / line-of-business applications that generate revenue. The model numbers (see Figure 1) help differentiate the capabilities of the processors and in the case of the Intel Xeon processor E7 product family, the wayness or maximum number of processors (CPUs or sockets) in a node can be two, four, or eight (contrasted to the Intel Xeon processor E3 or E5 families, which support only one or two/four processors, respectively). Performance may scale as the number of processors installed (wayness) in a server is increased (up to 94% efficiency as published in this paper); but in a two-way server, regardless of the actual processor wayness *capability,* the throughput application performance would be expected to be the same.

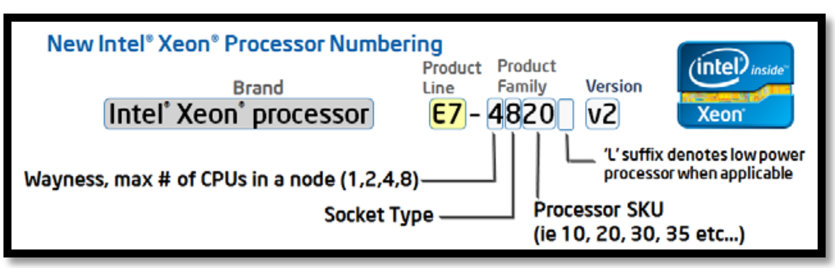

Figure 1 - 2012 Processor Numbering Example

MODEL NUMBERS AND SCALABILITY

For the Intel Xeon processor E7 family, processor models (also called SKUs) are available in three wayness configurations – two, four, or eight socket native support (no third party node controller required to connect the sockets together). Within a given Intel Xeon processor E7-xxxx SKU, the difference in wayness is irrelevant if populated in only a two-socket node and corresponding performance differences are negligible. For example, the top-bin Intel Xeon processor E7-8870/E7-4870/E7-2870 all have the same socket type (8) and the same processor SKU (70); which indicates same core frequency of 2.4 GHz, the same Intel® QuickPath Interconnect speed of 6.4 GT/s, the same last-level cache (LLC) of 30 MB, and the same number of cores at 10 per processor.

So the only difference is in the first product family number represents wayness (2, 4, or 8) capability indicating that the Intel Xeon processor E7-4xxx and E7-8xxx models can scale natively beyond just 2-sockets (see Figure 2 below). It is common IT practice to buy "headroom" by purchasing a larger server but only initially partitioning a portion of the processor sockets for today's level of requirements allowing for future compute power expansion as the number of users, transactions, or problem fidelity increases. Ideally, with perfect scaling, you can double the number of users, for example, when doubling the number of processor compute power (assuming storage, memory, and I/O are scaled as to not be the bottleneck). However, when any of these otherwise identical processors are populated in 2-sockets only though, performance throughput should be expected to be the same.

S-Spec Number	Stepping	CPUID	Core Frequency (GHz) / Intel® QuickPath Interconnect (GT/s) / Intel® SMI (GT/s)	Number of Cores	Cache Size (MB)	Series
SLC3E	A-2	000206F2h	2.4 GHz/6.4 GT/s/6.4 GT/s	10	30 MB	E7-8870
SLC3T	A-2	000206F2h	2.4 GHz/6.4 GT/s/6.4 GT/s	10	30 MB	E7-4870
SLC3U	A-2	000206F2h	2.4 GHz/6.4 GT/s/6.4 GT/s	10	30 MB	E7-2870

Figure 2 - Intel® Xeon® Processor E7-8800/4800/2800 Product Family Numbering[2]

PERFORMANCE IMPACT

For the purposes of demonstrating the impact of model numbers on performance, the top of the advanced capability levels of each product family is compared below (Intel Xeon processor E7-8870/4870/2870). Figure 3 below illustrates the options original equipment manufacturers (OEMs) have in designing an Intel Xeon processor E7 family-based server.

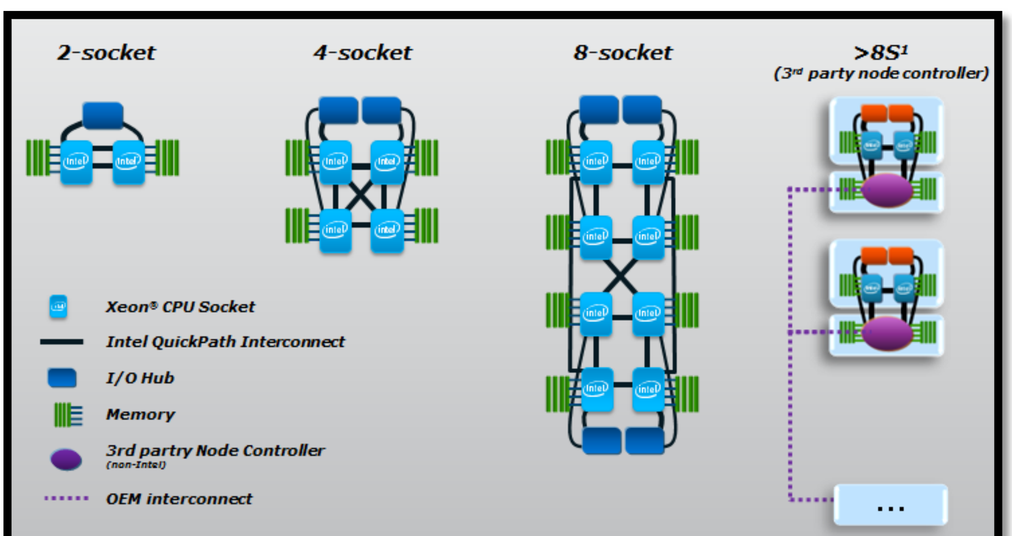

Figure 3 - Intel Xeon processor E7 family scalability to support 2- to 256-sockets[3]

Looking at the first number in the Intel Xeon processor E7 family, -8xxx, -4xxx or -2xxx, which represents the number of processors natively supported in a server, the processors can scale to support the increased number of users, transactions or throughput as additional sockets are tested in performance benchmarks. The typical example of this can be found while using the SPECint*_rate_base2006 benchmark that is fairly representative of typical integer-based, compute-intensive server applications to test the number of users (typically matches the number of logical threads seen by the Operating System, OS) simultaneously running a problem on a given server. The performance scaling is calculated by dividing the resulting score from the maximum number of processors populated in one server by the score of the server with n-way processors populated in another server configuration. So from 2- to 4- to 8-socket-based servers, the perfect scaling would be four times, meaning that the number of users supported (or problems solved) in the 8-socket server is four times more than what a 2-socket server could support. The efficiency is measured by how close a scale-up server performs comparatively to that perfect scaling, which in this case is quite reasonable at up to 94% efficiency (see Figure 4 below).

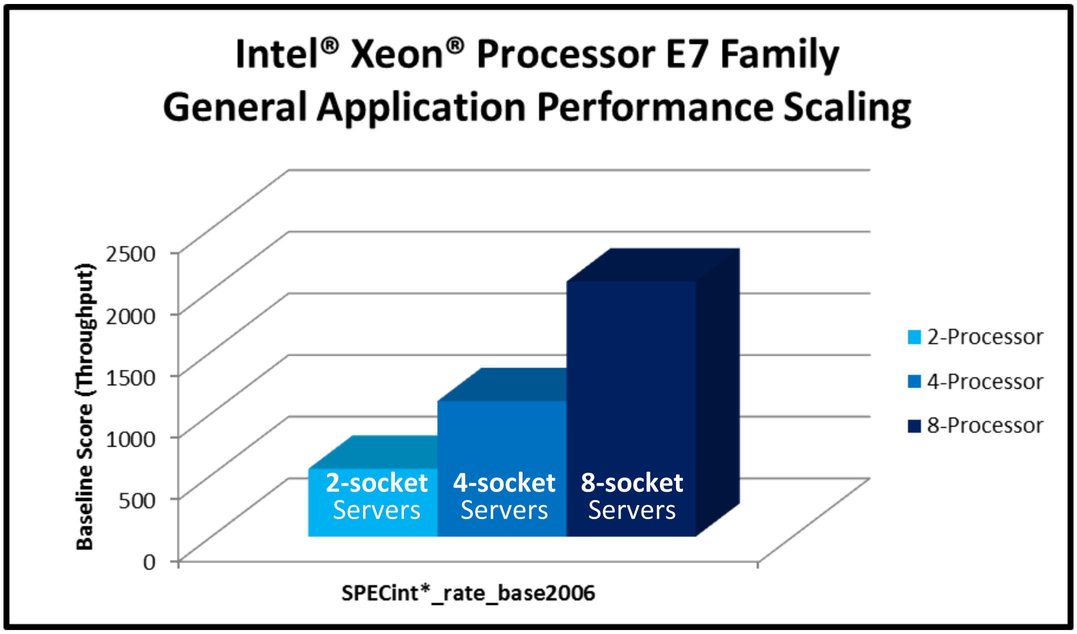

Figure 4 - Scaling of supported users on multi-processor servers[4]

The Intel Xeon processor E7-8870 can be populated in a 2-, 4-, or 8-socket server configuration. This is due to the Intel® QuickPath Interconnect (Intel® QPI) that allows the processors to share resources by allowing all of the components to access other components through the mainboard network. Similar to the Intel Xeon processor E7-8870, the E7-4870 model supports 2- or 4-socket server configurations; but on the Intel Xeon processor E7-2870, only 2-sockets can be populated in a server node (though multiple nodes can be joined together to form a larger single server image ≥2S – see Figure 3 above).

There are no characteristics in each of the three processors noted above that differ, other than the wayness capability. All three processors operate in the same number of available cores per socket, core frequency, Intel® QPI speed, and cache structure (see Figure 2 above). Therefore, in a 2-socket server configuration, the performance delta between the three will only be typical run-to-run variation due to a number of factors including manufacturing variances that may affect the length of time the processors run above their marked frequency using Intel® TurboBoost Technology. SPEC* allows for up to 1.75% variation. This hypothesis was confirmed through testing using Intel internal labs and as seen in Figure 5 below as there is less than 0.5% difference in performance between the three processors when in the same two-socket server configuration (see Table 1 below for complete list of equivalent processor SKUs).

Table 1 - Intel Xeon processor E7 family model numbers and wayness supported

Wayness	Intel® Xeon® Processor E7-8800/4800/2800 Product Family Equivalent Performance			
2-Sockets Native	E7-2870 / E7-4870 / E7-8870	E7-2860 / E7-4860 / E7-8860	E7-2850 / E7-4850 / E7-8850	E7-2830 / E7-4830 / E7-8830
4-Sockets Native	E7-4870 / E7-8870	E7-4860 / E7-8860	E7-4850 / E7-8850	E7-4830 / E7-8830
8-Sockets Native	E7-8870	E7-8860	E7-8850	E7-8830

CONCLUSION

Servers are very complex machines, especially in the "big iron" class where multi-processor configurations are the norm. The Intel Xeon processor E7 family is designed to support a multitude of shipping configurations and the model numbering schema is attempting to clarify the wayness and feature choices that customers have. In the current generation Intel Xeon processor E7 family scalable platform situation, the performance throughput increases at up to 94% efficiency from 2- to 8-sockets. However, in a two-socket server configuration, there is no appreciable difference in performance regardless of the processor SKU chosen – Intel Xeon processors E7-8870/4870/2870 and others shown in Table 1 above are equivalent.

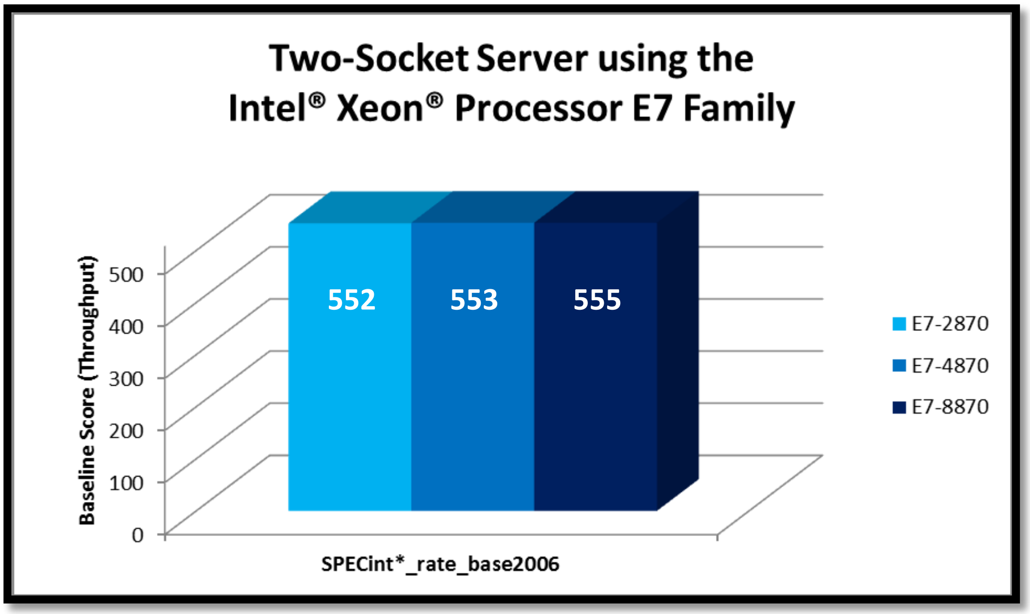

Figure 5 - 2-socket Server Performance using Intel Xeon processors E7-8870/4870/2870[5]

NOTES / SOURCES

1. See http://www.intel.com/content/www/us/en/processors/processor-numbers.html for more information on the Intel Xeon processor numbering.
2. See http://www.intel.com/content/dam/www/public/us/en/documents/specification-updates/xeon-e7-8800-4800-2800-families-specification-update.pdf for more information on Intel Xeon processor E7 family identification information.
3. Additional Configurations via OEM-specific scaling technologies (up to 256-sockets)
4. Comparison based on best published Intel Xeon processor E7 results in a 2-, 4-, and 8-socket configuration using the SPECint*_rate_base2006 integer throughput benchmark that is often used as a proxy for general server application performance.
    a. 8-socket server: Hewlett-Packard ProLiant* DL980 G7 scoring 2070 baseline.
    Source: http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20110923-18595.html
    b. 4-socket server: Cisco UCS* C460 M2 scoring 1100 baseline.
    Source: http://www.spec.org/cpu2006/results/res2012q1/cpu2006-20111223-19278.html
    c. 2-socket server: IBM System x* 3690 X5 scoring 550 baseline.
    Source: http://www.spec.org/cpu2006/results/res2012q3/cpu2006-20120716-23707.html
5. Comparison based on Intel internal testing on Intel Xeon processor E7 family using SPECint*_rate_base2006 benchmark baseline scores. System Configuration: Intel® C606 Chipset based reference platform (see http://www.qsscit.com/en/01_product/02_detail.php?mid=27&sid=125&id=126&qs=50 for details) supporting two each Intel Xeon processors E7-8870, E7-4870, and E7-2870 populated in sockets 0 and 1 with 128 GB memory (32x 4 GB DR DDR3-1066 RDIMMs), Red Hat* Enterprise LINUX 6.2, Intel Compiler XE2012 (12.1) compiled binaries. Source: Intel internal TR#1326 October 2012. See Appendix for details.

APPENDIX

Intel® Xeon® Processor E7-2870							
	Base	Base	Base	Peak	Peak	Peak	
Benchmarks	Copies	Run Time	Rate	Copies	Run Time	Rate	
--------------	------	---------	---------	------	---------	---------	
400.perlbench	40	923	423	*			
400.perlbench	40	926	422	S			
400.perlbench	40	921	424	S			
401.bzip2	40	1236	312	S			
401.bzip2	40	1235	313	*			
401.bzip2	40	1233	313	S			
403.gcc	40	750	429	*			
403.gcc	40	755	426	S			
403.gcc	40	747	431	S			
429.mcf	40	471	775	*			
429.mcf	40	472	774	S			
429.mcf	40	470	776	S			
445.gobmk	40	883	475	*			
445.gobmk	40	883	475	S			
445.gobmk	40	882	476	S			
456.hmmer	40	553	675	*			
456.hmmer	40	552	677	S			
456.hmmer	40	559	667	S			
458.sjeng	40	1065	454	S			
458.sjeng	40	1064	455	*			
458.sjeng	40	1063	455	S			
462.libquantum	40	247	3360	S			
462.libquantum	40	248	3340	S			
462.libquantum	40	247	3350	*			
464.h264ref	40	1314	674	S			
464.h264ref	40	1368	647	S			
464.h264ref	40	1368	647	*			
471.omnetpp	40	799	313	S			
471.omnetpp	40	799	313	*			
471.omnetpp	40	799	313	S			
473.astar	40	877	320	*			
473.astar	40	878	320	S			
473.astar	40	876	320	S			
483.xalancbmk	40	478	577	S			
483.xalancbmk	40	477	579	S			
483.xalancbmk	40	478	578	*			
===================	=======	======	=========	==================================			
400.perlbench	40	923	423	*			
401.bzip2	40	1235	313	*			
403.gcc	40	750	429	*			
429.mcf	40	471	775	*			
445.gobmk	40	883	475	*			
456.hmmer	40	553	675	*			
458.sjeng	40	1064	455	*			
462.libquantum	40	247	3350	*			
464.h264ref	40	1368	647	*			
471.omnetpp	40	799	313	*			
473.astar	40	877	320	*			
483.xalancbmk	40	478	578	*			
SPECint(R)_rate_base2006			**552**				
SPECint_rate2006				Not Run			

Intel® Xeon® Processor E7-4870							
	Base	Base	Base	Peak Peak Peak			
Benchmarks	Copies	Run Time	Rate	Copies Run Time Rate			
--------------	------	---------	---------	------ --------- ---------			
400.perlbench	40	922	424	*			
400.perlbench	40	924	423	S			
400.perlbench	40	918	426	S			
401.bzip2	40	1235	313	S			
401.bzip2	40	1234	313	*			
401.bzip2	40	1233	313	S			
403.gcc	40	746	432	S			
403.gcc	40	753	427	*			
403.gcc	40	763	422	S			
429.mcf	40	470	776	*			
429.mcf	40	472	774	S			
429.mcf	40	470	776	S			
445.gobmk	40	883	475	*			
445.gobmk	40	886	474	S			
445.gobmk	40	882	476	S			
456.hmmer	40	555	672	S			
456.hmmer	40	551	677	*			
456.hmmer	40	548	681	S			
458.sjeng	40	1064	455	*			
458.sjeng	40	1063	455	S			
458.sjeng	40	1065	454	S			
462.libquantum	40	247	3350	S			
462.libquantum	40	247	3360	*			
462.libquantum	40	247	3360	S			
464.h264ref	40	1325	668	S			
464.h264ref	40	1358	652	*			
464.h264ref	40	1367	647	S			
471.omnetpp	40	799	313	S			
471.omnetpp	40	799	313	*			
471.omnetpp	40	799	313	S			
473.astar	40	879	319	S			
473.astar	40	877	320	*			
473.astar	40	875	321	S			
483.xalancbmk	40	478	577	S			
483.xalancbmk	40	477	579	S			
483.xalancbmk	40	478	578	*			
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429.mcf	40	470	776	*			
445.gobmk	40	883	475	*			
456.hmmer	40	551	677	*			
458.sjeng	40	1064	455	*			
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429.mcf	40	471	774	S		
429.mcf	40	471	775	*		
445.gobmk	40	880	477	S		
445.gobmk	40	882	475	*		
445.gobmk	40	884	475	S		
456.hmmer	40	554	674	*		
456.hmmer	40	554	674	S		
456.hmmer	40	555	673	S		
458.sjeng	40	1066	454	S		
458.sjeng	40	1063	455	S		
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462.libquantum	40	247	3360	S		
462.libquantum	40	247	3350	*		
464.h264ref	40	1314	674	*		
464.h264ref	40	1313	674	S		
464.h264ref	40	1335	663	S		
471.omnetpp	40	798	313	*		
471.omnetpp	40	798	313	S		
471.omnetpp	40	798	313	S		
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SPECint(R)_rate_base2006			**555**			
SPECint_rate2006				Not Run		

Author

Frank Jensen is a Performance Engineer in Intel's Data Center Marketing Group

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